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**Report of Samuel C. Busey, M. D., and George M. Kober, M. D., of Washington, D. C.,
on morbific and infectious milk.**

The advance sheets of this interesting report, which will appear in the report of the health officer of the District of Columbia for 1895, have just been received, and the following extracts are herewith presented. The authors preface their report as follows:

In view of the importance of milk as an article of diet for infants, children, invalids, the sick, and convalescents, it is perfectly natural that much attention should have been given to the study of this food stuff, and that of late years the sanitarian and bacteriologist should also have found it a profitable field for research.

Few countries until recently have deemed it necessary to do more than prevent adulteration of the milk, and many of our legislators appear to think that as long as the milk has not been skimmed or watered, and contains the standard of 12 or 13 per cent of total solids, we need not worry about the germs we eat or drink. This may be a pleasing reflection to persons who do not know that such hydra-headed diseases as scarlet fever, diphtheria, and cholera infantum have been disseminated in the milk supply, that typhoid fever epidemics have been thus caused, and that milk may be the vehicle of the germs of tuberculosis and other infectious diseases and morbific agents.

For the sake of completeness we will refer to all the conditions likely to affect the quality of the milk and thereby render it morbific, and divide the subject into several groups.

The first section of the report deals with milk which is objectionable by reason of abnormal color, odor, taste, and consistency.

Abnormally colored milk.—Fuchs was the first to point out that blue and yellow colored milk may be due to the presence of chromogenic micro-organisms, and Neelson, in 1880, and Hueppe, in 1881, proved that blue milk was caused by the bacillus cyanogenus, which may even invade the udder of the cow. Mosler and Uffelmann refer to

cases of gastrointestinal catarrh, produced by the consumption of such milk. The color produced by chromogenic germs is usually superficial, and, according to Schröter, is due to the development of various anilines, such as aniline blue and fuchsin, from the casein; a uniform blue color is imparted by adulteration with water and certain kinds of cows' feed, and by some drugs.

Yellow milk may be due to the addition of coloring matter such as annatto or saffron or the development of the bacillus synxanthus (Schröter), but may also be caused by the ingestion of rhubarb (Mosler). Red milk may be caused by rhubarb or the presence of the *B. prodigiosus*, the *spirillum rubrum*, the admixture of blood, especially when the milk looks streaky, but is most frequently due to feeding the animals madder or bedstraw. Brown milk may be due to the presence of foreign matter or the products of certain fungi. A bluish-red color is caused by the *bacterium lactis erythrogenes* (Hueppe), while green milk is generally the result of an excess of fat and incomplete emulsification, sometimes due to the presence of the *bacillus fluorescens*, and occasionally, as in suppurative affections of the udder, to the presence of green pus.

Abnormal odor, taste, and consistency.—This may be caused by the character of the food, exposure of the milk to air charged with foul vapors as shown by Tait, or the presence of foreign matter. The odor of onions is imparted when any of the alia are eaten, and after the ingestion of even a small quantity of skunk cabbage the milk yields the characteristic odor. The consumption of turnips, cabbage, or decaying leaves frequently affects the flavor of the milk. Milk is said to acquire a bitter taste after the ingestion of wormwood or when the animal suffers from disease of the liver interfering with the proper elimination of the biliary acids and salts, but is most frequently due to the presence of certain forms of bacteria, most frequently present in dark, damp, and badly ventilated milk houses; a salty milk often results from cattle grazing upon marshy salt grasses.

Occasionally we see a stringy or filamentous milk which, according to Schmidt-Mülheim, may be due to the presence of certain micrococci, very generally found in dirty milk pans or other utensils; sometimes the milk is slimy, and several species of bacteria have been described as the cause of this condition; chief of these organisms is the *bacillus lactis viscosus*, isolated by Adametz. In rare instances milk presents a soapy taste, which, according to Weigmann, is due to a specific bacillus. It is needless to add that all such milk is unfit for use; indeed, there is very little danger from this source, as few persons would accept such milk and fewer still will be found willing to take chances in selling the milk, although they may work it off with other milk. The matter, however, is of even greater interest to the dairyman on account of the possible loss involved in such infections.

Colostral milk and the milk yielded three to five days before calving differs in composition from normal milk; the former frequently contains blood corpuscles from the vaginal passages. Dr. Heisch reports the case of a family using such milk who were attacked with symptoms resembling severe influenza, with high fever and great soreness of the inside of the mouth, throat, and tongue, which were covered with small pustules. The servants, who took only the skimmed milk, remained unaffected. One child who for two days refused everything but water got pretty well rid of her symptoms, but they returned as soon as she began to use the milk, which led to the examination of the milk, which was found to contain pus and blood corpuscles, also colostrum or a body

closely resembling it. According to Höhne milk yielded by animals a few days before calving has induced diarrhea and colic in the consumers.

Milk sediments.—Every consumer of milk has doubtless observed the presence of more or less foreign matter found at the bottom of the vessel or bottle in which it is kept; indeed, it is a matter of such common occurrence that it hardly excites our attention, and many are disposed to look upon it as a matter of course. Professor Soxhlet, of Munich, was perhaps the first to point out that these deposits are largely made up of excrementitious matter from the cow, which, adhering to the udder of the animal, gained access to the bucket in the act of milking. Professor Renk, of Halle, brought this subject to the attention of the section of hygiene at the International Medical Congress, held in Berlin in 1890, and no one of his audience is likely to forget the valuable object lesson presented by him.

These filtrates were so disgusting in appearance that we were not disposed to accept them as a standard for American milk, and with the courteous consent of Dr. Woodward, health officer of this city, Professor Hird kindly prepared for us filters from 24 specimens of Washington market milk taken at random, with the result that they presented even a greater amount of impurities, weighing all the way from 5 to 30 milligrams, and as fecal matter contains about 85 per cent of moisture, the weight of undried filth in the maximum specimen would have been about 180 milligrams per quart.

Now, it is not at all likely that the average American housewife would tolerate anyone throwing that amount of filth into her milk pitcher, and yet practically we suffer it to be done, and there is no law to prevent it.

These matters are hardly brought home to us when we talk about so many grains or grams of filth. Indeed, there is nothing so effectual as an object lesson, which every consumer can prepare for himself in the manner indicated, and if this should prove too tedious, it is simply necessary to examine the bottom of an average milk bottle after standing a few hours.

If these sediments are subjected to microscopical examination we will find, as shown in the accompanying microphotographs, prepared through the kindness of Surgeon Reed by Dr. Gray, of the Army Medical Museum, that they are composed of epithelial débris, hairs of the cow, excrementitious matter, vegetable fibers, organic and inorganic dust particles, bacteria, fungi, and spores of every description—fully 90 per cent of the germs are fecal bacilli—all of which is not only disgusting, but extremely suggestive of danger. The number of microorganisms in such milk is largely increased, and while there is no evidence that milk of this description, when taken perfectly fresh, has proved injurious to the consumer, we know that bacterial development and consequent decomposition is materially hastened in such a medium, and that the conversion of lactic sugar into lactic acid, apart from impairing the nutritive value, may cause gastrointestinal disorders in delicate infants.

Dr. H. C. Plaut, of Leipsic, found as a rule that in warm weather the so-called fresh milk delivered in the morning had already passed the period of incubation and was unfit for use by young children, and of 47 infants whose milk supply was carefully investigated by him, 18 developed, under such conditions, digestive disorders, and 6 died.

The greatest danger from milk of this class is the possible presence of tyrotoxicon and other toxins or bacterial products. Professor Vaughan believes that the former poison is developed by the growth of a germ, which under favorable conditions multiplies with astonishing rapidity.

The presence of the very filth referred to, a summer heat, and the pernicious habit of placing the milk before cooling in covered cans or bottles, perhaps dirty besides, constitute favorable environments for the development of this poison.

Cases of poisoning by milk and ice cream were reported long before we knew the nature of this poison, by Haschek, Hagner, Cameron, and Barruel, Orfila, Marjolini, Bonorden, Hasset, Schröff, and others, quoted by Husemann, with symptoms of nausea, vomiting, dryness, and a sense of constriction of the throat, vertigo, colic, purging, with a tendency in some cases to collapse, in others to numbness of the extremities and stupor.

In 1884 Vaughan isolated a poison found in poisonous cheese and called it tyrotoxicon; in November, 1885, he found the same substance in old milk; in June, 1886, he demonstrated its presence in poisonous ice cream, and in milk which had already undergone lactic-acid fermentation, and called attention to the probable relation of tyrotoxicon to cholera infantum and other kindred diseases. In July, 1886, he found this poison in a sample of milk which had evidently caused the symptoms of cholera infantum in a babe 7 months of age. In April, 1887, Dr. Stanton, the health officer of Cincinnati, demonstrated tyrotoxicon in poisonous cream puffs. Professor Vaughan's views on the relation of this poison and saprophytic germs to cholera infantum and the summer diarrheas in bottle-fed children, so well presented in his articles on acute and chronic milk infection, are gaining ground and will doubtless lead to a great reform in the management of dairies. Flügge (*Zeitschfrit Hygiene*, July, 1894) found among the milk bacteria, especially those which are liable to resist the temperature of boiling, several varieties capable of evolving toxins, and Baginsky is also of the opinion that the intestinal disorders of infants are due to these poisonous products of germs.

The authors here give also a large number of cases of poisoning by milk and milk products. * * *

Section 2 of the report deals with—

MILK RENDERED UNFIT FOR USE BY IMPROPER FOOD AND CARE OF THE ANIMAL.

The disease described as milk sickness or trembles by some American writers, and characterized by great weakness, constipation, vomiting, fetor of breath, and muscular twitchings, is believed to be due to cows feeding on *Rhus toxicodendron*. The evidence on this subject is, however, conflicting. Cases of diarrhea, and even severe forms of gastro-enteritis, have been traced by Sonnenberger, Ratti, and Mackay to the milk of cows and goats feeding upon meadow saffron and euphorbiaceous plants. The milk of animals fed on carrot and turnip tops and often from the first spring pasture is changed in an unaccountable manner, and has frequently caused vomiting and diarrhea in hand-fed children. Husemann regards among the meadow plants apart from different species of *Euphorbia* and *Ranunculus*, also the *Gratiola officinalis*, *Aethusa Cynapium* or fool's parsley, *Cytisus Ramentaceus*, and different varieties of sorrel and mushrooms especially objectionable.

The milk of swill-fed animals has often a peculiar taste and odor, and is said to cause hyperacidity of the urine and consequent eczema. M. Toussaint called attention to the fact that in the district of Argenteuil deaths from gastrointestinal diseases have increased in frequency among bottle-fed children since the establishment of a large distillery, the cows being fed on brewers' grain and other distillery pro-

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ducts, and the milk presented an acid reaction. But this acidity is by no means constant, as Uffelmann and Ohlsen have often found it alkaline. Ostertag states that the milk of animals fed with expressed sugar beets is destructive to calves on account of the excess of potassium, and hence objectionable for human consumption. Bollinger reports injurious effects from ricinus oil cakes, and Schmidt-Mühlheim attributes diarrheal attacks to the admixture of wild mustard in the rape seed oil cakes fed to cows. Colah quotes Herkemer as saying that cows having inhaled the putrid emanations of a dead and decomposing cow yielded a milk quite unfit for making cheese, and Mr. Smee, quoted by the same writer, asserts that "the milk of cows fed on sewage farms rapidly putrifies." It is quite true that cows, whenever an opportunity affords, feed greedily upon animal and human ordure, and an impure water supply for cattle has frequently been accused of causing an epidemic of milk typhoid. While this connection is not proven, it will be readily understood how the udder can become infected while the animal is wading in filth and polluted streams. Dr. J. H. Warren in 1880 called attention to the cow pastures in the vicinity of Boston, where the grass is reeking with sewage filth and sediment washed there by the tide, and that this condition might be the means of conveying disease through the medium of the milk. All of which clearly indicates the necessity of sanitary control of dairies, enforced cleanliness in milking, and the proper care and feeding of the animals.

Section 3 treats of—

MILK WHICH HAS ACQUIRED INJURIOUS PROPERTIES WHILE THE ANIMALS ARE BEING TREATED WITH STRONG MINERAL OR VEGETABLE AGENTS, OR WHICH MAY HAVE BEEN ACCIDENTALLY SWALLOWED.

This is true of the following substances, which have been eliminated in the milk, viz: Arsenic, lead, iodine, copper, mercury, tartar emetic, carbolic acid, opium and morphine, colchicum, and euphorbium. Dr. James Law reports an extensive outbreak of ergotism among animals, affecting also calves, presumably through the milk; and Baum refers to salicylic acid, atropia, veratrum, strychnine, croton oil, aloes, senna, and turpentine as likely to affect the milk.

Here follows the report of illustrative cases. * * *

Section 4 of the report is quite important and deals with—

MILK WHICH MAY BE MORBIFIC AS THE PRODUCT OF A DISEASED ANIMAL.

Inflammatory conditions of the udder and teats (garget.)—There is an abundance of evidence to show that cows frequently suffer from various degrees of mastitis and other septic processes of this secreting organ. It is obvious that the character and composition of the milk in such instances is changed, and apart from the disgusting admixture of pus, may prove dangerous by the transmission of septic germs, such as the various forms of streptococci and the staphylococci, which have actually been demonstrated in such milk by Krüger, Nocard, and Mollerau, Kitt, Bang, and others, and we know from Löffler's experiments that milk also offers a suitable culture medium for such germs.

Professor Brown, quoted by Shirley Murphy, in speaking of a communicable udder disease of the cow, said :

Whatever the disease really might be, it was at least certain that the milk of cows suffering from it was contaminated with pus and other morbid products which might

very well be responsible for human disease, for infantile diarrhea, for instance. The condition of the milk can be judged best from the remark of a dairy boy, who said: "They could not drink the milk themselves and had sent it to London, but they hoped the poor people there would not suffer."

Dr. James Niven, health officer of Manchester, describes in the London Lancet, January 19, 1895, an epidemic affecting 160 consumers of a particular milk supply with symptoms of diarrhea, sickness, and abdominal pains. The milk had an odor resembling that of sweet pus, and examination revealed the presence of streptococci and a microbe having the characters of the bacillus coli communis. A searching inquiry at the farm resulted in the admission of the farmer that he had sold a cow on November 8 because she was suffering with garget, and that her milk had been mixed with the other supply. A similar milk infection was reported by Dr. Boxall in a recent number of the London Lancet.

As a matter of fact, many of the epidemics of scarlet fever and diphtheria in Great Britain have been attributed to a milk supply from animals suffering with local affections of the teats and udder. Thus, for instance, in November and December, 1885, an epidemic appeared at Marylebone, St. Pancras, and Hampstead, which Mr. W. H. Power, the sanitary inspector, traced to a particular milk farm at Hendon, but could discover no sign of scarlet fever at or near the dairy. Upon examination of the cows some of them were suffering from an ulcerative disease of the teats and udders, and from various other circumstances he inclined to the belief of the bovine origin of this disease.

This opinion was shared by the late Sir George Buchanan, and as medical officer of the local government board he requested Dr. Klein to make an examination of the disease observed among the milch cows at Hendon. Dr. Klein found certain micrococci in the diseased tissues and organs of these cows and in the discharge from their teats, and succeeded in growing these in a variety of culture media. Inoculation of calves with this material, whether from cultures or direct from the cow, produced a disease having unmistakable affinities both with the Hendon disease and human scarlatina. * * *

Klein found this microbe to inhabit the tissues and organs both of the human scarlatina patient and of the Hendon cow, and declared that we need no longer hesitate to call it the "micrococcus scarlatinæ." In 1887, Dr. Thin pointed out that at the time of the Hendon disease other herds were similarly attacked, but no outbreaks of scarlet fever had occurred among the consumers of the milk, but as some of the milkers had pimples and sores on their hands, he believed the Hendon disease to have been cowpox and that the scarlet fever epidemic may have originated in a laundry where some of the Hendon dairy hands lived. Professor Crookshank in 1887 and 1888 opposed Klein's theory, and maintained that the microbe was simply the streptococcus pyogenes, and subsequently Professor Brown presented an array of facts also adverse to the conclusions of Klein and Power. One of his strongest points was Professor Axe's statement that scarlet fever had existed in the vicinity of Hendon and hence the possibility of human infection being conveyed to the dairy farm.

* * * While there is no positive proof that there is a disease in the cow which is communicable, as scarlet fever or diphtheria, to man, there is nothing strained in the assumption that in these debatable instances, i. e., in 30 out of 109 epidemics of scarlet fever and diphtheria tabulated by us, we are dealing with a streptococcus or staphylococcus infection,

and it will often be impossible to differentiate clinically such attacks from true diphtheria and scarlet fever.

This entire question is by no means settled, but is one that merits the most searching investigation by pathologists and bacteriologists of medical and veterinary schools.

In addition to Klein's testimony as to the presence of a streptococcus in these cases, Prudden reports 24 cases of diphtheria, in which in all but two he demonstrated a streptococcus, probably identical with the streptococcus pyogenes and streptococcus erysipelatous. Baginsky (Berliner klin. Wochenschrift, 1892, No. 9, p. 183) reports that of 154 cases of diphtheria treated under his supervision, in 118 cases Löffler's bacillus was present, while in the remaining 36 only cocci (staphylococci and streptococci) could be demonstrated.

When we further consider that toxines may and do produce a scartaceous exanthem, we feel fully warranted in declaring that in all the epidemics of scarlet fever and diphtheria, which were traced to milk from cows suffering with some inflammatory lesions of the udder or from puerperal fever, we have typical instances of a streptococcus and staphylococcus infection, and we thus offer for the first time, so far as we know, a rational explanation of a question which has engendered so much heartburning among English pathologists.

Gastroenteric diseases.—It has long been held that the milk of cows suffering from digestive derangements is of an abnormal character, and, according to Siedamgrotzky, Fröhner, and Braüer, it is usually quite watery, of a bitter taste, and generally coagulates within six to eight hours after milking, with the formation of very little acid, so-called "sweet curdling." When we remember that if nursing mothers indulge freely in fresh fruit and green vegetables their milk is apt to gripe and purge their infants, we can appreciate how cows' milk, under the above circumstances, may produce mischief.

Acute specific enteritis.—Professor Gaffky has reported several cases which he traced to the milk of an animal suffering from this disease and demonstrated a characteristic organism in the animal as well as in his human patients. He also referred to an epidemic of gastroenteritis reported by Professor Husemann which prevailed in 1888 at Christiana and within three weeks affected over 6,000 persons, but sparing infants at the breast, and concludes, from his own observation and the smaller epidemics which preceded the extensive outbreak together with the fact that the bacteriological examination at Christiana revealed a similar organism, that the germs of "infectious enteritis" may be conveyed in milk. Indeed, it is quite possible that some of the epidemics of typhoid fever with an atypical course are infections of this character.

Fever, especially puerperal and other septic fevers.—The milk of animals suffering from febrile diseases is unfit for use. This is especially true of the puerperal and other septic fevers, in which Karlinski, Escherich, Longard, and Adametz have demonstrated the presence of the micrococcus pyogenes aureus in milk, the last-named author in a sample which had induced vomiting and diarrhea, and there is reason for believing that the germs of septicaemia neonatorum are in many instances conveyed in the milk, since Escherich, who examined 13 specimens of milk from mothers suffering from puerperal fever, found the pyogenic germs in 12, and Karlinski not only demonstrated the staphylococci in the milk of the mother, but also in the blood and intestinal contents of the infected infant.

Foot and mouth disease (eczema epizootica).—The milk from animals suffering from this disease is unfit for use, and many epidemics of

stomatitis aphthosa or aphthous fever have been reported. According to Dr. Salmon, of the Bureau of Animal Industry, this epizootic does not now prevail in the United States, the last cases having occurred in Maine about eleven years ago. There is, of course, danger from a return of the disease at any time, which annually affects about 10 per cent of the cattle in Europe.

The report presents a large amount of evidence on the subject.

Cowpox.—The milk of animals suffering with this disease is believed to have caused 2 epidemics of a peculiar type of sore throat in a boys' college at Edinburgh in 1886 and 1887. While Drs. Williams and Woodhead may have erred, as is claimed, in the diagnosis of cowpox, there is no good reason why the milk from such animals should not prove infectious.

Anthrax.—The milk of animals infected with anthrax is unfit for use, because Feser, Manotzkoff, Nocard, and others have actually demonstrated the bacillus anthracis in the milk, and if infection has not more frequently taken place, it is because the secretion is arrested in the very first stage of the disease. * * * (Here follows the report of illustrative cases.)

Pleuropneumonia.—It is claimed that the milk of animals suffering from this disease may convey the germs, and Lécuyer, Schüppel, Jürgensen, and others have actually reported a number of transmissions, but the question is by no means settled. Fortunately, the disease has been stamped out in the United States; at least Dr. Salmon informs us that there has not been a case reported within the last three years.

Rabies and tetanus.—There has always been considerable diversity of opinion as to the infectious qualities of milk from animals suffering from rabies. In olden times the consumption of such milk was regarded as dangerous, and Faber refers to a few instances of transmission of the disease in human milk, which all date back to the last century. Feeding experiments have proved in the majority of instances negative, and Hertwig, Bollinger, Reder, Fröhner, and others concluded from them that there was no danger from this source.

Since Pasteur pointed out, however, that the mammary glands were among the organs selected for the deposition of the virus, there has been a renewed interest in the subject, and Nocard has experimentally proven that the virus may be conveyed in the milk. Burdach also determined, in the Pasteur Institute, that the milk of a woman bitten by a rabid wolf proved infectious to rabbits and guinea pigs, but was quite harmless to the child. This question remains unsettled, as the accidental admixture of virus outside of the body in the Pasteur Institute is not excluded, but all authors agree that cows may suffer from hydrophobia, and that the milk should not be used. It is not improbable that the milk of animals suffering from tetanus contains some of the specific bacterial products, but it seems almost inconceivable that animals suffering from these affections should be milked at all.

*Tuberculosis.**—When it is remembered that one-seventh of all the deaths are due to tuberculosis, and that the identity of bovine and human tuberculosis has been settled beyond question, we need not wonder that much attention has been given to the study of milk from tuberculous cows.

Ostertag gives the percentage of tubercular animals in 1885 at the

* While it is of course possible for milk to be contaminated with the sputum or tubercular matter of consumptives, we are considering here the transmission of the germs from the animal to man through the medium of milk.

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abattoir at Leipsic, 15 per cent; at Stolph, 20.7 per cent; Bromberg, 26.2 per cent; while that for the Berlin abattoirs is much higher; indeed, 53.7 per cent of the old fattened milch cows presented tubercular lesions of the bronchial and mediastinal glands. According to Rieck, of 67,077 cattle slaughtered at Leipsic during the years 1888-1891, 20.4 per cent were found to be tubercular and about 3.6 per cent of the tubercular animals in Saxony presented lesions of the udder.

Dr. H. C. Ernst presents evidence from 39 veterinarians, representing 17 States, most of them reporting for one year only, which indicates that there were 549 cases of tuberculosis and 242 suspicious cases, a total of 791 among 165 herds representing about 3,000 animals, i. e., 18 per cent of positively tubercular animals and over 8 per cent of suspicious cases, a total of about 26 per cent; and, according to De Schweinitz, in many cases from 50 to 70 per cent of the dairy herds were found to be infected, and in one of these the veterinarian had reported that fully 50 per cent of the diseased animals had tuberculosis of the udder. The English and Danish statistics also show an alarming prevalence among the dairy herds.

The possibility of the presence of tubercle bacilli in the milk of animals was pointed out first by Virchow, and by Koch as early as 1882, and subsequently the bacilli have been demonstrated by Bang, Johné, Bollinger, Ernst, Woodhead, and MacFadyean, and many others, in the milk of animals in which the udder was also the seat of the lesion, and for some time it was doubted whether the milk from a cow is virulent unless the udder is the seat of tuberculous deposits. In the report of the royal commission on tuberculosis presented to Parliament April 23, 1895, Dr. Martin from his experiments, finds that milk was infective only when the udder was itself the seat of tuberculous disease, and this is also the conclusion reached by Nocard.

Dr. Woodhead, in the same report, however, calls attention to the rapidity with which the udder disease may spread and considers the very absence of any definite sign in the earlier stage as one of the greatest changes of this condition. Both Drs. Martin and Woodhead insist that no tuberculous animal of any kind should be allowed to remain in a dairy, and recommend as a preventive measure the simple expedient of putting every suspected milk over the fire and taking it off when it boils.

The experience of the royal commissioners is quite different in some respects from that of Ernst, whose preliminary work in 1889 led him to declare emphatically that the milk from cows affected with tuberculosis in any part of the body may contain the virus of the disease, and that the virus is present whether there is disease of the udder or not. In 1893, Theobald Smith, from a number of experimental observations, finds that tubercle bacilli may be present in the milk of tuberculous cows when the udder, so far as the naked eye could tell, contained no foci of disease, and the results presented by Ernst in his recent and final report on the infectiousness of milk appear fully to justify his former conclusions, which are, moreover, supported by the investigations of Bang, May, Stein, and Hirschberger, the latter being also the first to point out that the inoculation experiments are the more certain guide as to whether the milk is infectious or not, as he obtained positive results from milk of undoubted tuberculous animals, in which he was unable to demonstrate the presence of tubercle bacilli. Indeed, evidence has been furnished by Galtier that the infectious properties may also be conveyed in the butter, cheese, and other milk products of tuberculous cows.

The general results of inoculation experiments would seem to indicate that milk may prove infectious in 60 to 70 per cent of the cases; that the infectious qualities are greatest with milk from animals with udder lesions, and next from those affected with general tuberculosis. The feeding experiments of Bang, Bollinger, Lucas and Morro, Utz, Johné, Klebs, Kruckow, Ernst, Baumgarten, Fischer, and Wesener with tuberculous milk proved infectious in about 45 to 50 per cent of the cases.

When we recall the fact that the last three observers in their feeding experiments were especially impressed with the resulting tuberculous lesions of the intestinal mucosa, mesenteric glands, and liver; when we next consider the large mortality of children under 5 years from primary tubercular ulceration of the intestines (Cohnheim, and Aufrecht), tubercular peritonitis and tabes mesenterica, and the fact that the food of these children consists largely of unboiled milk, the chain of evidence seems well-nigh complete, but has been materially strengthened by a number of clinical cases.

Professor Klencke, in an excellent little work published at Leipsic in 1846, accuses cows' milk as a frequent cause of disease in children, and deeply regrets that this indispensable article of food, for which no suitable substitute can be found, should at times contain a virulent poison, not easily demonstrated except by its effects stamped upon the countenance of numerous cachectic children, and maintains that there is a positive connection between the milk of scrofulous and tuberculous cows and the frequent development of scrofula in bottle-fed children. He calls attention to the fact that stall-fed, and especially swill-fed cows are peculiarly prone to become tuberculous, and describes the condition of seven cows which he closely studied, five of which furnished an abnormal milk, and the diagnosis of a "scrofulous-tuberculous condition" was confirmed post-mortem in four of the cows.

Klencke gives the clinical history of 16 children who had been fed with milk from these cows, and all point to tuberculosis of either the intestines, glands, skin, or bone. In three of the intestinal disorders he refers to the presence of indurated mesenteric glands. Of the 16 cases one died, but at the time of his report two of the children were still suffering with "intestinal blennorrhea and scrofulous abdominal glands," and he feared that, in spite of the change of milk, these patients would perish. In the fatal case, that died from an abscess of the left breast, the autopsy revealed "a true infiltration of tubercular matter beneath the skin, which had probably acted as a foreign body and excited an exhausting suppurative process."

Unfortunately, nothing is said about the pathological conditions found elsewhere, but it must be remembered that Klencke was only endeavoring to prove the transmission of scrofula. In this connection we can hardly resist the conclusion that the difference in degree of virulence observed in the various tubercular manifestations is perhaps not always attributable to the condition of the host, but may possibly be due to an attenuated character of the tubercle bacilli. Whether or not the German habit of boiling the milk, or adding boiling water, or the action of the gastric juice modifies the virulence of the bacilli, as shown by the slower forms of tuberculosis, remains to be seen; but in the feeding experiments with raw and boiled milk, of Bollinger in 1878, and Bang in 1890, we notice a marked difference in the resulting lesions. We have not seen the full report of the royal commission on tuberculosis, but from the abstract published in the British Medical Journal, page 948, April 27, 1895, it would appear that Dr. Woodhead noted the

effects of temperatures insufficient for its actual destruction upon the virulence of tuberculous material.

By the operation of certain low temperatures he obtained a diminution in the virulence of the tuberculous material in the milk, which then became "so tardy in its operation on test animals as to simulate the slower forms of consumption seen in the human subject, or when used to feed pigs—animals having some specialties of throat structure like that of man—gave rise to chronic enlargements of the throat glands, resembling the scrofulous glands so common in children. These observations are of much interest to us, not least because they suggest the possibility of widely prevalent forms of human tuberculosis owing an origin in milk."

Dr. Ernst's recent clinical inquiry on the transmission of bovine tuberculosis revealed the following facts: Eighteen hundred circulars were sent to physicians and veterinarians asking if they knew of any cases in which human beings had been infected with tuberculosis through the milk of cows. Among 1,013 replies from physicians 895 were negative, 8 reported cases of infection of a child by the mother, 11 reported cases of infection by cows' milk, and 16 reported suspicious cases. The veterinarians gave much more striking evidence, since among 54 replies 14 reported positive, and 9, suspicious cases.

The positive replies quoted by Dr. Ernst are not such as will be considered conclusive evidence by pathologists, and really lack scientific accuracy. While the development of *tabes mesenterica*, *phthisis*, tubercular meningitis, glandular affections, etc., occurring in hand-fed babies of perfectly healthy parentage points with suspicion to the milk supply, the investigation should be extended, as Klencke had done fifty years ago, whenever practicable to the animals, and with our present opportunities for bacteriological investigations, some valuable facts may thus be collected.

Johne reports a striking case in which a post-mortem examination of the cow revealed extensive tuberculous deposits. The steward of the farm was especially interested in the result of the investigation, as on account of the previous good condition of the animal the milk had been selected for his infant son. The family physician was at once notified, and reported progressive emaciation and a "pulmonary catarrh" which he had attributed to a recent attack of measles; a short time afterwards Johne received word that the boy, then 2½ years old, had succumbed to an attack of miliary cerebral tuberculosis. This case is of special interest because there was no hereditary predisposition, and the other children in the family are perfectly healthy.

Hermsdorf relates the case of a girl 14 years of age, of healthy parentage, who developed tubercular laryngitis and tuberculosis of the ileum and caecum, which he attributed to the milk of a tuberculous cow. This girl was in the habit of drinking the milk while still warm.

Leonhard mentions a family in which the children contracted tuberculosis soon after being weaned. The cow was finally suspected and killed, and the diagnosis confirmed. The next child in the family remained in good health. He also mentions two cases of tubercular meningitis traced to the use of unboiled milk from a tuberculous cow. Demme reports five cases observed in the children's hospital at Berne infected by tuberculous milk. Sonntag, Meyerhoff, Stang, Schöngen, and Uffelmann report similar cases. Epstein in his extensive experience, finds that children from consumptive parents rarely develop the disease when provided with a healthy wet nurse, and attributes the frequency of intestinal tuberculosis to the infectious qualities of the milk. Herterich relates

two cases, which he attributed to the milk of a tuberculous mother. Brouardel cites a case where five out of fourteen girls living in a boarding house became consumptive subsequently to the use of milk from a tuberculous cow. * * *

The report concludes with a section on—

MILK WHICH ACQUIRES INFECTIVE PROPERTIES GENERALLY ONLY AFTER IT LEAVES THE UDDER OF THE ANIMAL.

Numerous instances having been observed in which outbreaks of typhoid fever, scarlet fever, and diphtheria, by their sudden and explosive character, affecting families living in streets or localities supplied by the same milkman, naturally pointed to the milk supply as a common cause; but to Dr. Michael Taylor belongs the honor of being the first to point out definitely that cows' milk might serve as the medium of spreading typhoid fever from a dairy where the disease prevailed. In 1867 Dr. Taylor also showed that scarlatina might be distributed in the same way. In 1877 Mr. Jacob traced a diphtheria epidemic at Sutton to the milk supply, and in 1872 Macnamara traced an epidemic of cholera at Calcutta to an infected dairy.

These facts could not fail to invite criticism and sharpen the power of observation in others, and in consequence similar outbreaks were more frequently reported, so that Mr. Ernest Hart in a most valuable paper, was enabled to present to the International Medical Congress, held in London, 1881, the history of 50 outbreaks of typhoid fever, 15 of scarlet fever, and 7 of diphtheria, all traceable to the milk supply; but even this formidable array of facts was not accepted as conclusive, largely because the milk industry constitutes a strong spoke in the commercial wheel, and naturally opposed what they considered meddlesome interference with their trade, and in many instances were upheld by members of our profession who considered the evidence wholly circumstantial and incomplete as long as the specific germ of the respective diseases had not been demonstrated in the suspected milk. While this link in the chain of evidence would be very desirable, it will be well for those who exact it and completely ignore the reports, many of which are masterpieces of medical logic, to remember that by the time we are able to connect a certain outbreak with a particular dairy, days, and sometimes a week or two, will have elapsed, the germs have been distributed, are probably exhausted, and thus a most opportune time for their detection will have been lost. An approach in this direction worthy of emulation has, however, been made by Professor Vaughan before the Congress of Hygiene and Demography, in London, August, 1891, when he declared:

Milk has been frequently diluted with water containing the germs of typhoid fever, and the prevalence of the disease may mark the daily rounds of the milkman. I have here a culture tube containing a bacillus, which I found simultaneously in the water from the dairy well and in the milk from the cans. At the same time one or more cases of typhoid fever existed in every family which patronized this milkman. The bacillus resembles, but is not identical with, that of Eberth.

It is of course well known that Professor Vaughan believes that different forms of bacteria may induce typhoid fever. But even if the specific germs of the diseases in question should never be demonstrated in suspected milk, we know from the bacteriological studies of Heim, Löffler, Kitasato, Raskina, Sonnenberger, Riedel, Wolfhügel, Hesse, Frünkel, and others that milk is a favorable culture medium for the germs of

typhoid, cholera, erysipelas, pneumonia, and other pyogenic germs; also for the bacillus of tuberculosis, as shown by Heim, and which Gasperini even found in butter 120 days old.

Adametz has cultivated the bacillus of diphtheria and of glanders in sterilized milk. This is at least strong corroborative evidence, and must be especially gratifying to English authors, who have been charged with going altogether too far in their attempts to regulate the sale of milk.

Cholera.—Professor Koch, in 1884, first pointed out that milk is a suitable culture medium for the cholera bacillus, but the possibility of the virus being transmitted in the milk had been emphasized before. Gaffky, in the report of the cholera commission in India, in discussing this subject, refers to the unsanitary conditions of the dairies in India, where the water supply is derived from tanks which are promiscuously used for bathing, laundry, and dairy purposes, and as Dr. Payne, the health officer of Calcutta, in his report for 1876, expressed it, "milch cows are stalled in the neighborhood, and the nearest water is freely mixed with the milk and distributed through the town." Dr. Cayley refers to the fact and consequent danger that at Katarhatti, a suburb of Calcutta of 300 families, 70 are engaged in the milk business, all located near one of these notorious water tanks, and that in September, 1872, not less than 16 cholera cases with 6 deaths occurred among these dairy people.

Dr. Macnamara reports an outbreak in a boarding house at Calcutta attacking six Europeans and the cook of their department, while the other inmates and servants of the house escaped; they had all consumed the milk from a particular dairy, and it was determined that immediately before this outbreak 8 cases of cholera had occurred in close vicinity of the water tank used by this milkman. Dr. Simpson, health officer at Calcutta, describes a limited epidemic which occurred on board the ship *Ardenclutha*, resulting in 9 cases and 4 deaths, and affecting, with one exception, consumers of a particular milk derived from a dairy located near a tank into which dejecta from a cholera patient found access, and the milkman, with unusual frankness, also admitted that he had diluted his milk with one-fourth water from this tank. Surgeon-Major Cunningham, in an excellent paper on milk as a medium for cholera bacilli, has called attention to the fact that the presence of germs whose growth is associated with impure and contaminated milk, as in India, and consequent acid fermentation, is destructive to the development or existence of organisms which, like the comma bacilli, require an alkaline or neutral medium.

EPIDEMICS OF MILK TYPHOID, SCARLATINA AND DIPHTHERIA, SORE THROAT AND ERYSIPELAS.

We know now that disease germs may not only survive, but in many instances actually proliferate in the milk, and it is not a difficult matter to point out the many ways by which they may gain access, especially when some of the employees connected with the dairy or farm are also engaged in nursing the sick, or are suffering themselves from some mild infection while continuing their usual duties, or are convalescents from the disease.

It is quite conceivable how animals wading in filth and polluted water may infect the udder and through it the milk. We can also appreciate how infected water may convey the germs by washing the utensils or by deliberate adulterations. Infection may also take place through the

agency of scrubbing brushes, dishcloths, insects, exposure to contaminated air, etc.

TYPHOID FEVER EPIDEMICS.

Mr. E. Hart tabulated 50 epidemics of typhoid fever and we have collected 88, making a total of 138 epidemics traceable to a specific pollution of the milk, the main facts of which are presented in a subjoined table. In 109 instances there is evidence of the disease having prevailed at the farm or dairy. In 54 epidemics the poison reached the milk by soakage of the germs into the well water with which the utensils were washed, and in 14 of these instances the intentional dilution with polluted water is admitted. In 6 instances the infection is attributed to the cows drinking or wading in sewage-polluted water. In 3 instances the infection was spread in ice cream prepared in infected premises. In 21 instances the dairy employees also acted as nurses. In 6 instances the patients, while suffering from a mild attack of enteric fever, or during the first week or ten days of their illness, continued at work, and those of us who are familiar with the personal habits of the average dairy boy will have no difficulty in surmising the manner of direct digital infection. In 1 instance the milk tins were washed with the same dishcloth used among the fever patients. In 1 instance the disease was attributed to an abscess of the udder (?), in another to a teat eruption (?), and in still another to a febrile disorder (?) in the cows. In 4 instances the disease was spread through the medium of creameries, and in 1 instance the milk had been kept in the sick-room.

SCARLET FEVER EPIDEMICS.

Mr. Hart collected statistics of 15 epidemics of milk scarlatina, and we have tabulated 59, making a total of 74 epidemics spread through the medium of the milk supply (?).

In 41 instances the disease prevailed either at the milk farm or dairy. In 6 instances persons connected with the dairy either lodged in or had visited infected houses. In another instance the milkman had taken his can into an infected house. In 20 instances the infection was attributed to disease among the milch cows; in 4 of these the puerperal condition of the animal is blamed. In 9 instances disease of the udder or teats was found. In 1 instance the veterinarian diagnosed a case of bovine tuberculosis. In 6 instances there was loss of hair and casting of the skin in the animal. In another instance the cattle were found to be suffering more or less from febrile disturbance. In 10 instances the infection was doubtless conveyed by persons connected with the milk business, while suffering or recovering from an attack of the disease, and in at least 8 cases by persons who also acted as nurses. In 3 instances the milk had been kept in the cottage close to the sick-room. In another instance the cows were milked into an open tin can, which was carried across an open yard past an infected house, and in another instance the milkman had wiped his cans with white flannel cloths (presumably infected) which had been left in his barn by a peddler. Two epidemics appear to have been instances of mixed infection of scarlet fever and diphtheria.

DIPHTHERIA EPIDEMICS.

Mr. Hart collected statistics of 7 epidemics of milk diphtheria, and we have added 21 more. In 10 of these 28 instances diphtheria existed at the farm or dairy, and in 10 instances the disease is attributed

February 14, 1896

directly to the cows having garget, chapped, and ulcerative affections of the teats and udder, while in one instance the cows were apparently healthy, but the calves had diarrhea. In another, one of the dairy-maids suffered from a sore throat of an erysipelatous character; in another the patient continued to milk while suffering from diphtheria. In still another, one of the drivers of the dairy wagons was suffering from a sore throat.

It is difficult, if not impossible, to account for the infectious qualities of the milk in those epidemics where scarlet fever and diphtheria could not be found at the milk farm or shops, unless we are permitted to look to the cows themselves as a source of infection, and for reasons already given, we feel justified in believing that in many instances we have to deal with a staphylococcus or streptococcus infection, while in the typhoid epidemics traced to milk farms or shops, where no cases of enteric fever could be found, we are either forced to the conclusion that the specific germs remained dormant for a long time, or that certain harmless bacteria may acquire virulent properties by suitable environments which, unfortunately too often, exist in connection with our milk farms. The extreme possibility of the infectious germs entering the cans or bottles while the milk is in transit from the farms and shops to the customers in all these obscure instances deserves to be mentioned.

It is interesting to note that of 138 epidemics of milk typhoid, 74 of scarlet fever, and 28 of diphtheria, a total of 240 epidemics, 187 have been recorded by English authors, 31 by American, and 9 by Scandinavian; 8 came from German, 3 from Australian, and 1 each from French and Swiss sources.

Whether this is due to the fact that on the Continent of Europe milk is rarely used in a raw state, or whether it is simply an index of the greater interest taken in England and the United States in "preventive medicine," remains to be determined.

We fail to see, however, wherein Dr. Scholl is justified in regarding the epidemics reported by American physicians with suspicion, when, as a matter of fact, the reports compare favorably with those of the best English authors in the presentation of evidence and attention to details. Dr. Scholl should remember that it was, after all, an American physician who first demonstrated the nature of cheese poison, which, as venenum casei, had baffled the efforts of European scientists for over a century, and that the same Professor Vaughan was also the first physician who presented bacteriological evidence in an instance of milk typhoid infection. * * *

The report in full covers nearly 100 pages and contains not only a most complete presentation of the evidence on morbific milk, but also a tabulated statement of the numerous milk-borne epidemics of typhoid fever, scarlet fever, and diphtheria.

[Reports to the Supervising Surgeon-General Marine-Hospital Service.]

Smallpox in Memphis.

MEMPHIS, TENN., February 1, 1896.

SIR: I have the honor to report with reference to the smallpox in this city that 44 cases and 6 suspected cases have arisen in the city and